

WHAT IS CLAIMED IS:

1. A semiconductor device comprising a semiconductor region having a plurality of semiconductor crystalline grains joined with {111}-twin boundaries of Diamond structure and a gate electrode covering the surface of said semiconductor region via an insulating film.

2. A semiconductor device comprising an insulator; a semiconductor layer having a plurality of semiconductor crystalline grains provided at the upper part of said insulator to have one main surface, said semiconductor crystalline grains having {110}-planes to form said main surface, the interfaces of which are joined by {111} twin-boundaries; and a gate electrode covering said main surface of said semiconductor layer via an insulating film.

3. A thin-film semiconductor device comprising an insulator, a thin-film semiconductor layer provided at the upper part of said insulator to have a source region and drain region which are separated from each other, a gate insulating film covering the surface portion of said semiconductor layer between said source region and said drain region, and a gate electrode provided on said gate insulating film, said semiconductor layer provided between said source region and said drain region comprising a plurality of semiconductor crystalline grains joined with {111} twin-boundaries of Diamond structure.

1 4. A thin-film semiconductor device comprising an insulator, a polycrystalline layer formed on said insulator, and a transistor comprising a source region, a drain region, a gate region, and a channel region formed at the surface portion of said polycrystalline layer, said polycrystalline layer comprising crystal grains of an element selected from the group of Type-IV elements and the alloys thereof, said crystal grains joined with crystal grain boundaries of {111} twin of Diamond structure.

10 5. A thin-film semiconductor device as claimed in claim 4, wherein, in at least one current path connecting said source region and said drain region, at least one of the crystal grain boundaries crossing said current path is said {111} twin of Diamond structure.

15 ^{Sub B.7} 6. A thin-film semiconductor device as claimed in claim 4, wherein said insulator is a glass substrate, said polycrystalline layer is a Si thin-film, said Si thin-film has a thickness of 10 to 150 nm, and said Si thin-film has a plurality of crystal grains having {110} planes parallel to the surface of said substrate .

20 7. A thin-film semiconductor device as claimed in claim 4, wherein in said channel region the two to five crystal grains having the joints of said {111} twin have {110} planes parallel to the surface of said insulator, and have at least one structure

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cont } coupled at one point on said polycrystalline layer.

8. A thin-film semiconductor device as claimed in claim
4, wherein said polycrystalline layer has a structure where
n-layer (n is 1 or larger) of semiconductor thin film is
5 laminated, said transistor comprising said source region, drain
region, channel region and gate electrode is formed at the
surface of n-th semiconductor layer, the k-th (k = 1 to n)
semiconductor layer has said poly-crystal having the larger
crystal grain size as the value of k increases and the grain
10 boundary of the n-th semiconductor layer has the {111} twin of
Diamond structure.

9. A thin-film semiconductor device comprising an
insulator, a semiconductor thin-film formed on said insulator
and a transistor comprising a source region, a drain region,
15 a channel region and a gate electrode formed at the surface of
said semiconductor thin-film, said semiconductor thin-film
having amorphous regions of Type-IV element and dendrite crystal
regions of Type-IV element connecting said source region and
said drain region.

20 10. A thin-film semiconductor device as claimed in claim
9, wherein, in at least one current path formed by said dendrite
crystal region connecting said source region and said drain
region, at least one of the crystal grain boundaries crossing
said current path is {111} twin of Diamond structure.

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~~16. An insulated-gate type thin-film semiconductor device comprising an insulator, a thin-film semiconductor layer having~~

a source region and a drain region which are separated from each other, a gate insulating film covering the surface of said semiconductor layer between said source region and said drain region, and a gate electrode separated from said semiconductor layer via said gate insulating film therebetween, said semiconductor layer between said source region and said drain region having the thickness of 10 to 150 nm and a polycrystalline surface with electron mobility of 260 to 500 $\text{cm}^2/(\text{V} \cdot \text{s})$.

17. A thin-film semiconductor integrated circuit device comprising a plurality of thin-film semiconductor devices as claimed in claim 16 integrated on said insulator.

18. A liquid-crystal display device comprising a first thin-film integrated circuit having a plurality of first thin-film transistors to form the matrix element for the liquid-crystal display and a second thin-film integrated circuit having a plurality of second thin-film transistors to form the peripheral circuit driving said matrix element, both circuits integrally formed in a semiconductor thin-film layer provided at the upper part of one common insulating substrate, each of said thin-film transistors of said first thin-film integrated circuit and said second thin-film integrated circuit having a semiconductor active region formed of a plurality of semiconductor crystalline grains joined by {111} twin boundaries of Diamond structure between a source and a drain

~~thereof, and a liquid-crystal provided at the upper part of said first thin-film integrated circuit.~~

19. A liquid-crystal display device comprising a first thin-film integrated circuit having a plurality of first thin-film transistors to form the matrix element for the liquid-crystal display and a second thin-film integrated circuit having a plurality of second thin-film transistors to form the peripheral circuit driving said matrix element formed integrally in a semiconductor thin-film provided at the upper part of a common insulating substrate, each thin-film transistor forming said first and second thin-film integrated circuits comprising a poly-crystal semiconductor active region having the electron mobility of 260 to 500 cm²/(V · s) between a source and a drain thereof, and a liquid-crystal member provided at the upper part of said first thin-film integrated circuit.

20. A liquid-crystal display device as claimed in claim 18, wherein said insulating substrate is formed of glass material and said liquid-crystal member has the liquid-crystal display area of the diagonal length of 15 inch or more.

21. A method of manufacturing a thin-film semiconductor device comprising the steps of forming a gate insulating film by oxidizing a surface of a semiconductor thin-film having a plurality of semiconductor crystalline grains joined by at least one {111} twin boundary of Diamond structure and forming a gate

22. A method of manufacturing a thin-film semiconductor device comprising the steps of forming an amorphous semiconductor thin-film partially provided with a seed crystal metal at the surface thereof on a major surface of an insulator, and crystallizing said semiconductor thin-film with a direction from said seed crystal metal to said major surface of said insulator substrate by annealing said semiconductor thin-film.

24. A method of manufacturing a thin-film semiconductor device comprising the steps of depositing an amorphous Si thin-film with the thickness of 10 to 150 nm at the upper part of an insulator, providing seed crystal metal on the surface of said thin-film except for the surface of a channel forming area, annealing said amorphous Si thin-film at the temperature

of 600°C or lower, and providing a gate electrode to the surface of said channel forming area of said Si thin-film via a gate insulating film.

25. A method of manufacturing a thin-film semiconductor device as claimed in claim 24, wherein said insulator is of a glass substrate and said amorphous Si thin-film is formed by heat treatment under the temperature range from 300°C to 600°C.

26. A method of manufacturing a thin-film semiconductor device comprising the steps of depositing a first amorphous Si thin-film at the upper part of an insulator, providing a seed crystal metal to a first thin-film area except for an active region of the thin-film transistor, crystallizing said first Si thin-film by annealing, depositing a second amorphous Si thin-film at the upper part of said first Si thin-film thus-obtained, forming crystal grains of Si jointed by twin boundaries in said second thin-film area of the active region by annealing said second thin-film, providing a gate insulating film on the surface of said active region of said second thin-film, and providing a gate electrode on said gate insulating film.

27. A method of manufacturing a thin-film semiconductor device as claimed in claim 21, wherein said semiconductor thin-film is of the element selected from the group of Type-IV element and an alloy thereof.

28. A method of manufacturing a thin-film semiconductor device as claimed in claim 22, wherein said seed crystal metal is of the element selected from the group of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ru, Rh, Pd, Ag, Os, Ir, Pt and Au, alloys thereof, and compounds of said metal and Type-IV element, or is of a laminated structure of said metal and said Type-IV element.

29. A method of manufacturing a thin-film semiconductor device as claimed in claim 23, wherein a bottle-neck region is formed between said seed crystal metal and the channel forming surface area in said amorphous thin-film before conducting said heat treatment, by selectively removing a part of said amorphous thin-film .

30. A thin-film semiconductor integrated circuit device comprising a semiconductor thin-film layer provided at the upper part of an insulator, a plurality of insulated- gate type semiconductor elements formed at said semiconductor thin-film layer, each of said semiconductor elements having a gate electrode separated from said semiconductor thin-film layer by a gate insulating film at the surface of said semiconductor thin-film layer, and a seed crystal metal located between at least two of said gate insulating films and provided on the surface of said semiconductor thin-film layer except for the areas just under said gate insulating films.

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